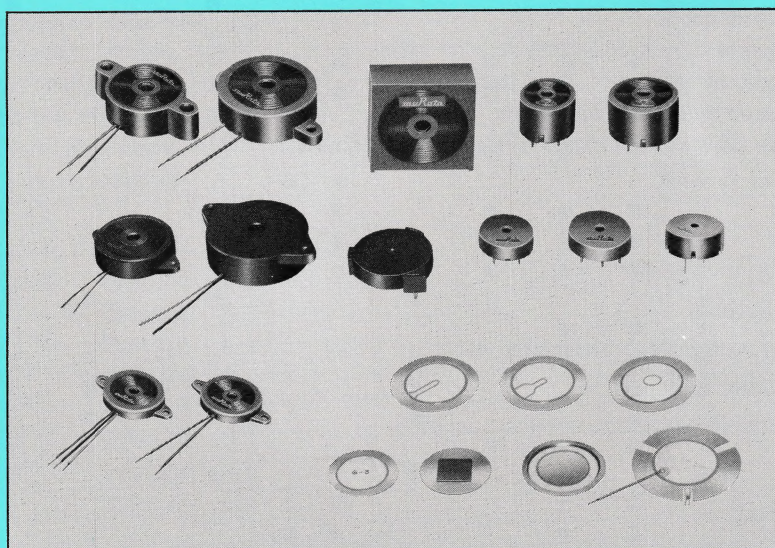




# **PIEZO-ELECTRIC BUZZER**

## **MANUAL**

### **PIEZO BUZZER APPLICATION**



MURATA MFG.CO.,LTD.

Cat.No.P15E-3



# 1. Application Matrix of Piezo Buzzer

Table 1 summarizes how the Murata's products mentioned so far are applied in various fields. Piezo-electric buzzers

are expected to expand its scope of applications currently divided into three categories of notification, strong notification and warning.

Table 1

		Part Number	Watch-Clock	Calculator	Camera Stroboscope	Smoke detector Burglar alarm	Game machine	Telephone	E C R	T V	Stereo	Microwave oven	Auto-mobile	
Sound Element	Self drive type	7BB-20-6C			●									
		7BB-27-4C						●	●			●	●	
		7BB-35-3C					● ●		●	●	●	●	●	
		7BB-41-2C					● ●		●		●	●	●	
		7SB-34R7-3C					● ●							
	7SB-34R7-3C2					● ●								
	External drive type	7BB-20-6	● ●	● ●	● ●	● ●		●			● ●	●		
		7BB-27-4	● ●	● ●	● ●			●			● ●			
		7BB-35-3		● ●	● ●			● ●	● ●	● ●				● ●
		7BB-41-2		● ●	● ●			● ●	● ●	● ●				● ●
		7BB-20-12R5RM-7				● ●	● ●	●						
		7BB-27-12R5RM-4		● ●	● ●	● ●	● ●	●						
		7SB-20-7	● ●	● ●	● ●	● ●	● ●	●						
		7SB-21-7	● ●	● ●	● ●	● ●	● ●	●						
		7SB-27-5	● ●	● ●	● ●			●						
		7SB-21R5-6-1	●											
		7SB-31R8-2	●											
		7BB-19-8-1		● ●	● ●	● ●		●						
		7BB-41-2A1		● ●	● ●				● ●	● ●	● ●			
Housing Type		Self drive type	PKM11-6A0		●	●								
	PKM12-6A0			●	●									●
	PKM9-5A0						● ●		● ●	● ●		● ●		● ●
	PKM8-3A0						● ●		● ●	● ●		● ●		● ●
	PKM25-6A0			●		●								●
	PKM27-5A0								● ●	● ●		● ●		● ●
	PKM29-3A0						● ●							
	PKM37-2A0						● ●		● ●	● ●		● ●		● ●
	PKM37-3A0						● ●		● ●	● ●		● ●		● ●
	PKM37-4A0						● ●		● ●	● ●		● ●		● ●
	External drive type	PKM11-4A0		●	●	●		●	●			●		●
		PKM17-2A0								●	●			
		PKM17EP-4101	● ●	● ●	● ●	● ●	● ●	●		● ●	● ●			● ●
		PKM24-4A0	● ●	● ●	● ●	● ●	● ●	●			● ●	● ●		● ●
		PKM27-3A0	● ●	● ●	● ●			●			● ●			
		PKM28-2A0		● ●	● ●			● ●	● ●	● ●				● ●
	With Circuit	PKM35-4A0		●		● ●		●		●		●		
		PKB6-5A0					● ●			● ●			● ●	● ●
		PKB5-3A0					● ●			● ●			● ●	● ●
		PKB5-3B0					● ●			● ●			● ●	● ●
		PKB7-3A0					● ●			● ●			● ●	● ●
		PKB8-4A0					● ●		● ●	● ●			● ●	● ●
		PKB9-2A0					● ●		● ●	● ●			● ●	● ●
		PKB9-3A01					● ●		● ●	● ●			● ●	● ●
		PKB24SP-3301							● ●	● ●				

Applications:  
Fire Alarm  
Ga Detector  
Laundry Machine  
Bath  
Interphone  
Door Chime  
Portablepocket Bell  
Speed Alarm  
Back Buzzer  
ME Instruments  
Measuring Instruments  
Automatic Vending Machine  
Computer  
Bicycle  
Toys  
Radio  
Communication Instruments  
Tonometer  
Running Meter  
Facsimile  
Battery Charger  
Masher Alarm  
Audio Timer  
Thermos  
Razor  
Automatic Controlling Devices  
Weighing Instruments  
Source Fire Detector  
Hair Curler

## Introduction

MURATA is doing great efforts in developing new electronic components seeking an unlimited possibilities of the ceramic materials. MURATA was the first to develop piezo-electric ceramic in Japan, and it has responded to demands in the technical innovation of electronics providing series of products applying the piezo-electric ceramic such as ceramic filter, microfork and various ultrasonic transducers

### ■ Features

- 1) High sound pressure with low power level
- 2) Clear sound
- 3) Small size and light weight
- 4) High reliability and no noise due to the absence of contacts
- 5) Low cost

## 2. Oscillation System of Piezo Buzzer

The oscillation systems for Piezo-Electric Buzzer are classified into self-drive type ( Fig. 1 (a)) and external drive type ( Fig. 2 (b)). The former is applied when a specially large sound is required such as warnings, e.g. smoke detectors and alarm. The oscillating frequency in this method is determined by a resonant frequency which heavily depends upon a shape of the sound element (particularly diameter and thickness of the metal plate). In the latter method, the sound element oscillates at a certain frequency (2048 or 4096Hz for instance) externally applied by LSI and others such as in digital watches, calculators and telephones. It is therefore a convenient method when melody sounds are required or micro-computers are applied. The sound pressure in this type does not develop to the extent of the former. In this method the oscillation is characteristically made at the same frequency as the externally given frequency. Each component of the oscillation systems in Fig. 1 is described hereafter.

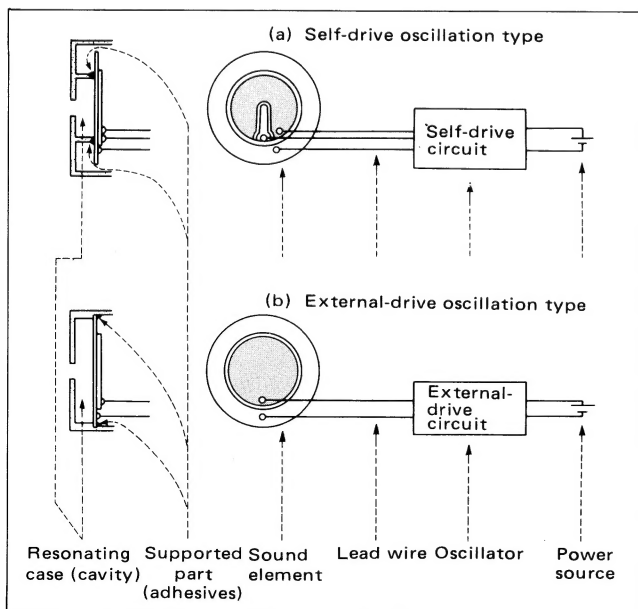


Fig. 1. Oscillation System of Piezo Buzzer

for the age of IC.

The "Piezo-Electric Buzzer" introduced here is a product based on an entirely new principle utilizing the vibration characteristic of the piezo-electric ceramic. This manual is prepared to assist you in using this piezo-electric buzzer most effectively and to further enhance the value added of your products.

### 2-1 Sound element and lead wire

The mode of free vibration of the sound element in a gravity-free state is the one having nodes as depicted in Fig. 2. Since an displacement is 0 at each node, the characteristic inherent in the sound element can be measured by applying a measuring terminal to the node without affecting the oscillation. The resonant frequency of the resonating case (cavity) is designed to be equivalent to the  $f_0$  (resonant frequency) of the sound element. The capacity relates itself to the impedance matching in self-drive circuit system. Although  $R_0$  leads to the effective oscillation, practically the  $R_0$  in a state where the sound element is mounted to the case relates with the sound pressure. For lead wires, the finest ones as possible are desirable since they give suppressing loads upon the vibration. AWG 32 is employed for our products as standard lead wire.

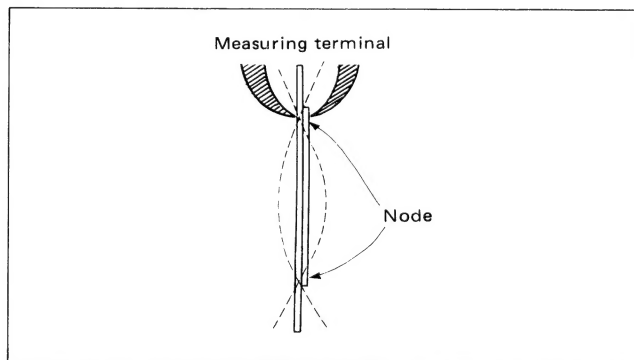


Fig. 2. Vibration of Sound Element

### 2-2 Lead wire soldering method

For lead wire soldering, keep soldering temperature of  $320 \pm 40^\circ\text{C}$  for 2 ~ 4 seconds for the metal plate, and the same temperature for less than 0.5 second for silver surface. The desirable soldering point for the metal plate is the center of ceramic-free area, and for the silver surface is the point nearest possible to the edge of silver surface as shown in the sound element figure for Fig. 1.

## 2-3 Supporting methods of sound element

Fig. 3 describes the principal supporting methods. Node support among them yields the most effective vibration due to the absence of suppression on vibration. Therefore, most of the self-drive oscillations are designed to employ node support so as to raise efficiency as well as sound pressure level. The following equation exists between node diameter  $d$  and metal plate diameter  $D$ ; however the practical values will be the ones shown in Table 2 due to the shape effects of piezo-electric ceramics.

$$d = 0.65D \dots \dots \dots$$

Therefore, the sound element, when used as self-drive oscillation with node support, requires to be supported in the circumference equivalent to the node diameter.

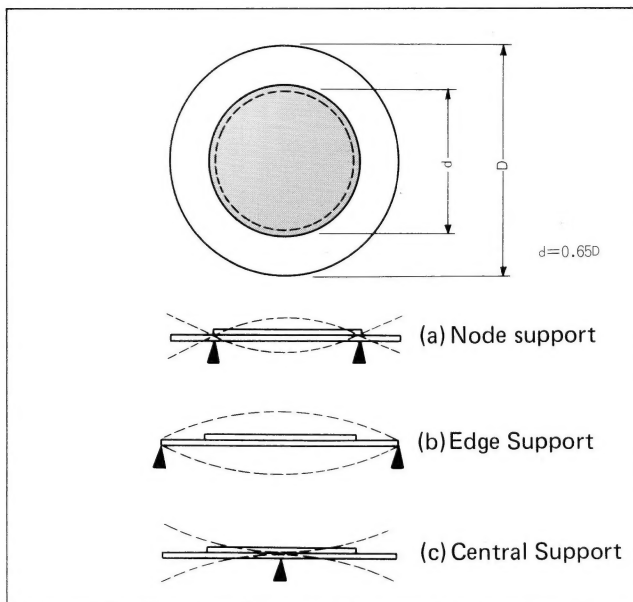


Fig. 3 . Supporting Methods of Sound Elements

Part No.	Node diameter
7BB-20-6C	about 13.0φ
7BB-27-4C	17.5 φ
7BB-35-3C	22.5 φ
7BB-41-2C	26.5 φ

(unit: mm)

\* The sound elements with no feedback electrode also have the same node diameters.

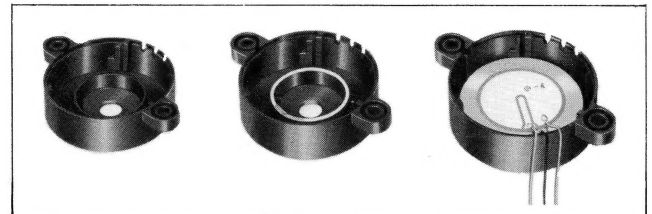
Table 2. Node Diameters of Sound Elements

Since the driving frequency depends upon an external circuit, the piezo-electric buzzer driven externally is so designed that the frequency characteristic might have broadband characteristic to minimize dispersion in the sound pressure of the given frequency. The edge support shown in Fig. 3 (b) is employed for this purpose. Although the theoretical ratio of edge support to node support in resonant frequency is 0.65 derived from the equation (1), the actual value exceeds 0.65 because of uneven thickness and materials. Moreover the edge support not only owns single resonant point reduced to 0.65 but also has the same

resonant modes as node support (PKM11-4AO: 6.7kHz, PKM17-2AO: 3.2kHz). A number of resonant points existing in these composite modes and compound modes can be said to make contributions to wideband frequency. Yet the oscillation efficiency and sound pressure reduces in edge support since it inhibits the vibration at the edge.

## 2-4 Bonding method of resonating case to sound element

For adhesives, silicone resins are best suited in terms of elasticity, thermal resistance, easy handling and moisture-proof. However, either epoxy type or conductive type can be employed without troubles for the edge support. Picture 1 shows the binding process.



Picture 1. Binding Process of Resonating Case to Sound Element

## 2-5 Design of resonating case

The power of sound is small when the sound element is merely supported because acoustical impedance hardly matches with air. In order to obtain a large sound pressure level, a case (resonating case) is required. The case can be designed in accordance with the following equation (Helmholtz's equation).

$$f_{o \text{ cav}} = \frac{C}{2\pi} \sqrt{\frac{\pi a^2}{V(\ell + ka)}} = \frac{C}{2\pi} \sqrt{\frac{4a^2}{d^2 h (\ell + ka)}} \dots \dots (2)$$

$f_{o \text{ cav}}$  : Resonant frequency of cavity Hz  
 $C$  : Sound velocity  $344 \times 10^2$  cm/sec at  $24^\circ\text{C}$   
 $a$  : Radius of sound emitting hole cm  
 $d$  : Diameter of support (= node diameter) cm  
 $h$  : Height of cavity cm  
 $\ell$  : Thickness of cavity  
 $k$  : Constant  $\sim 1.3$

Therefore the design is made in the following steps.

- 1) Determine the oscillating frequency, for example, 2.8kHz which is most appealing to human ears.
- 2) Select the sound element whose resonant frequency is around 2.8kHz. 7BB-35-3C
- 3) Node diameter  $d$  is fixed after the sound element is decided. 2.2cm
- 4) Determine thickness of the cavity, e.g. 0.1cm.
- 5) Determine  $h$  and  $a$  by shape balance and others. PKM8-3AO is designed on the basis of the above procedures.

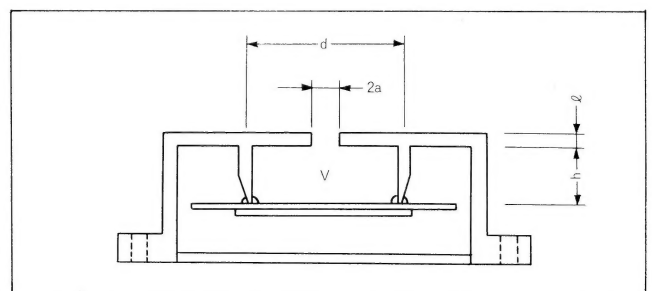


Fig. 4. Structure of Resonating Case

## 2. Self-Drive Oscillation

### 3-1 Product list:

#### Piezo-electric buzzers of self-drive oscillation type

Murata's standard items specially selected out of the sound elements, sound elements with cases and buzzers with built-

**Table 3. Product List of Sound Elements of Self-Drive Type**

Part Number	Characteristics (※ 1, ※ 2)			Dimensions (mm)					Description
	$f_0$ (KHz)	$R_0$ ( $\Omega$ )	$C_M$ (pF) $\pm 30\%$	$\phi D$	a	b	T	t	
7BB-20-6C	$6.3 \pm 0.6$	$\leq 500$	8500	$20.0 \pm 0.2$	$14.0 \pm 0.6$	$12.8 \pm 0.2$	$0.42 \pm 0.1$	$0.20 \pm 0.05$	——
7BB-27-4C	$4.6 \pm 0.5$	$\leq 200$	18000	$27.0 \pm 0.2$	$19.7 \pm 0.6$	$18.2 \pm 0.2$	$0.54 \pm 0.1$	$0.30 \pm 0.05$	——
7BB-35-3C	$2.8 \pm 0.5$	$\leq 200$	24000	$35.0 \pm 0.2$	$25.0 \pm 0.6$	$23.0 \pm 0.2$	$0.53 \pm 0.1$	$0.30 \pm 0.05$	——
7BB-41-2C	$2.2 \pm 0.3$	$\leq 250$	24000	$41.0 \pm 0.2$	$25.0 \pm 0.6$	$23.0 \pm 0.2$	$0.63 \pm 0.1$	$0.40 \pm 0.05$	——
7SB-34R7-3C	$3.3 \pm 0.3$	$\leq 150$	$\leq 40000$	$34.7 \pm 0.2$	$25.0 \pm 0.6$	$23.4 \pm 0.2$	$0.50 \pm 0.1$	$0.25 \pm 0.05$	——
7SB-34R7-3C2	$3.1 \pm 0.5$	$\leq 160$	24000	$34.7 \pm 0.2$	$25.0 \pm 0.6$	$23.0 \pm 0.2$	$0.50 \pm 0.1$	$0.25 \pm 0.05$	※ 3
7BB-20-6CA0	$6.3 \pm 0.6$	$\leq 800$	8500	$20.0 \pm 0.2$	$14.0 \pm 0.6$	$12.8 \pm 0.2$	$0.42 \pm 0.1$	$0.20 \pm 0.05$	AWG32 Use
7BB-27-4CA0	$4.6 \pm 0.5$	$\leq 200$	18000	$27.0 \pm 0.2$	$19.7 \pm 0.6$	$18.2 \pm 0.2$	$0.54 \pm 0.1$	$0.30 \pm 0.05$	
7BB-35-3CA0	$2.8 \pm 0.5$	$\leq 200$	24000	$35.0 \pm 0.2$	$25.0 \pm 0.6$	$23.0 \pm 0.2$	$0.53 \pm 0.1$	$0.30 \pm 0.05$	
7BB-41-2CA0	$2.2 \pm 0.3$	$\leq 350$	24000	$41.0 \pm 0.2$	$25.0 \pm 0.6$	$23.0 \pm 0.2$	$0.63 \pm 0.1$	$0.40 \pm 0.05$	

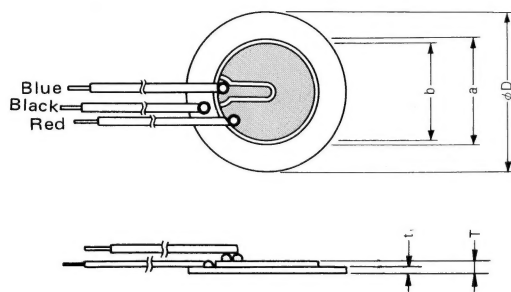
$f_0$  : Resonant frequency (KHz)  $C_M$  : Capacitance of main electrode (pF) at 1KHz

$R_0$  : Resonance resistance ( $\Omega$ )

\*1. Insulation resistance: 100M $\Omega$  min. (at 100VDC)

\*2. Maximum applied voltage: 30V<sub>p-p</sub>

\*3. Concentric circle feedback electrode type: Molex housing for ATM7373



Lead wire AWG32  
Total Length : 50 $\pm$ 5  
Stripped Margin : 5 $\pm$ 2  
Unit: mm

Part Numbering (\*Please specify the part number when ordering.)

7 B B - 35 - 12R5 RM - 3 C A 0  
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪

- ① Material of piezo-electric ceramic : p-7
- ② Material of metal plate B : Brass S : Stainless
- ③ Sound element (Bender)
- ④ Metal plate diameter
- ⑤ Dimension of piezo-electric ceramic

- ⑥ Form of piezo-electric ceramic
- ⑦ Ni-electrode
- ⑧ Oscillating frequency
- ⑨ With feedback electrode
- ⑩ With leadwire
- ⑪ Other specifications

Part No.	Characteristics				Operation range		Dimensions (mm)				
	f <sub>o</sub> (kHz)	S P L (dB)	I (mA)	Conditions (※ 1)	(DC-V) Voltage	(°C) Temp.	φ D	T	e	f <sub>1</sub>	f <sub>2</sub>
PKM11-6A0	6.5±0.7	≧75	≦ 8.0	10cm, 6.5 VDC, Cir. A	3.0~15	-20~70	—	—	—	—	—
PKM12-6A0	6.5±0.7	≧75	≦ 8.0	10cm, 6.5 VDC, Cir. A	3.0~15	-20~70	—	—	—	—	—
PKM 9-5A0	4.7±0.7	≧85	≦ 12.0	30cm, 9.0 VDC, Cir. A	3.0~20	-20~70	—	—	—	—	—
PKM 8-3A0	2.8±0.5	≧85	≦ 12.0	30cm, 9.0 VDC, Cir. A	3.0~20	-20~70	—	—	—	—	—
PKM25-6A0	6.8±0.7	≧85	≦ 10.0	10cm, 6.5 VDC, Cir. C	3.0~20	-20~70	25.0	7.0	6.5	4.0	8.5
PKM27-5A0	4.8±0.5	≧85	≦ 13.0	10cm, 9.0 VDC, Cir. C	3.0~20	-20~70	31.5	7.0	4.0	7.0	9.0
PKM29-3A0	3.4±0.4	≧85	≦ 18.0	1 m, 9.0 VDC	4.5~15	-20~70	39.0	16.0	4.0	4.0	10.5
PKM37-2A0	2.0±0.5	≧70	≦ 15.0	1 m 12 VDC, Cir. D	3.0~20	-20~70	—	—	—	—	—
PKM37-3A0	2.7±0.5	≧75	≦ 17	1 m 12VDC	3.0~20	-20~70	—	—	—	—	—
PKM37-4A0	3.7±0.5	≧75	≦ 15.0	1 m 12 VDC, Cir. D	3.0~20	-20~70	—	—	—	—	—

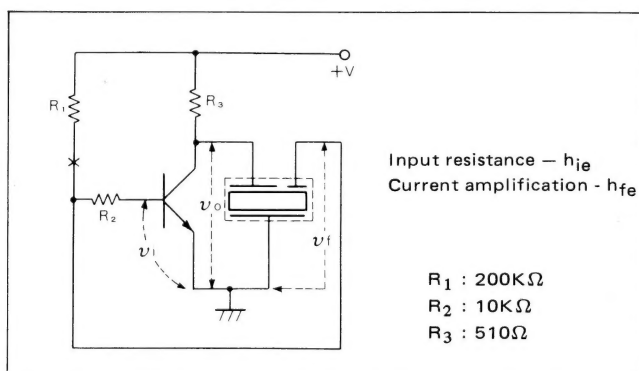


### 3-2 Self-Drive Circuit and Line Voltage

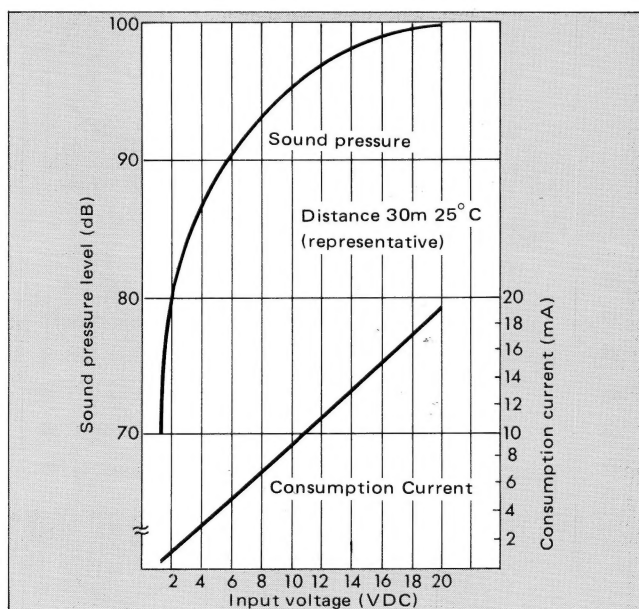
This circuit is a modified Hartley circuit with a grounding emitter in which an equivalent inductance and equivalent capacity of the sound element replace the functions of coil and capacity of the Hartley circuit. Stable sound production at high sound pressure level with low cost is the characteristic feature of this circuit which employs one transistor and three resistors per unit. Basic oscillating conditions for self-drive circuit are:

- Phase difference between  $V_o$  and  $V_f$  in Fig. 5 should not be less than  $180^\circ$ .
- $\frac{V_f}{V_o} \geq \frac{R_2 + h_{ie}}{h_{fe} \cdot R_3}$  should be satisfied. . . . . (3)
- $R_1$  should be set so that DC bias point  $V_{CE}$  of Tr could be one half of the line voltage.
- $R_2$  must be adjusted to avoid any spurious emission in oscillating waves.

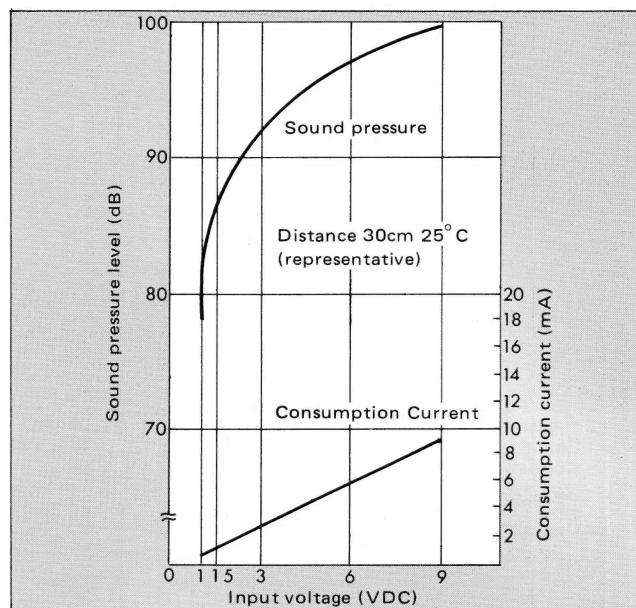
Designed value on the basis of the above conditions are,  $R_1 = 200k\Omega$ ,  $R_2 = 10k\Omega$ ,  $R_3 = 510\Omega$  and  $h_{fe}$  for  $Tr = 160 \sim 320$ . Line voltage characteristics of the products designed to satisfy these conditions are shown in Fig. 3–5.



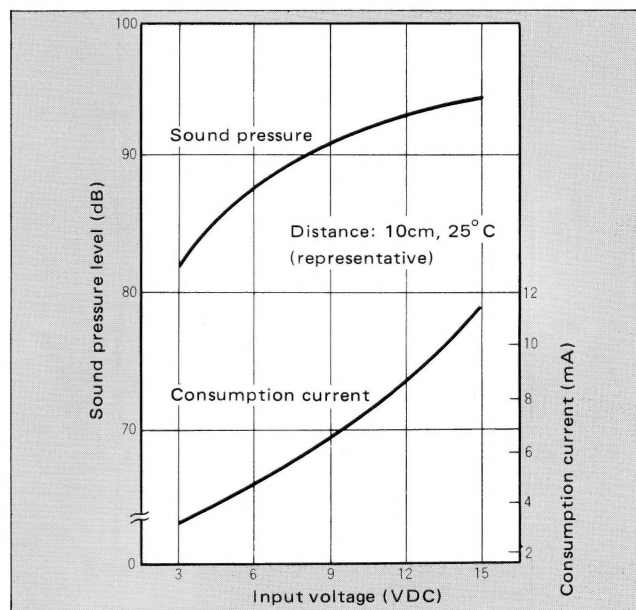
**Fig. 5. Self-Drive Circuit**



**Fig.6 . Line Voltage Characteristics of PKB5-3AO and PKB6-5AO**



**Fig. 7. Line Voltage Characteristic of PKB5-3BO**



**Fig. 8. Line Voltage Characteristic of PKM11-6AO**

### 3-3 Installation

- 1) It should be noted that the sounds might not be intermitted by ON—OFF change-over at X positions in Fig. 2, because the feedback voltage is not turned off by the change-over.
- 2) The inclusion of unnecessary emission in the oscillating waves might cause instability in the oscillating frequency.
- 3) The inter-electrode short circuit is recommended for safety prior to the operation, in order to avoid possible destruction of Tr by high voltage when the sound element having heavy electric charge due to thermal or mechanical shocks is connected to Tr.
- 4) The series resistor to electric power could cause oscillation stoppage or overtone oscillation.

### 3-4 Employment of IC

The driving circuit with CMOS inverter is described in Fig. 9. Any inverter or NAND gate IC, can constitute modified free running multi-vibrator circuit as in Fig. 9. The application of the voltage with its phase inverted by  $180^\circ$ , which is gained from the feedback electrode of the sound element, to inverter B through  $R_1$  forms the positive feedback loop and increases the sound pressure level. Fig. 10 and 11 show how the oscillating frequency or the sound pressure relates to the change in  $R_1$  or  $C_1$ .

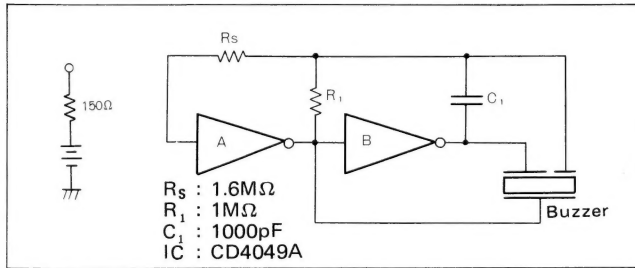


Fig. 9 IC Oscillation Circuit

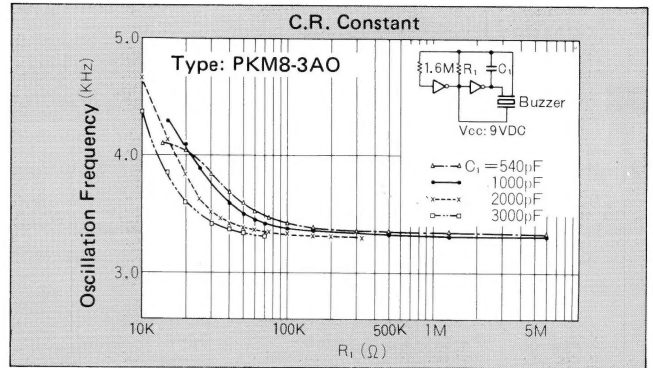


Fig. 10 Relations of  $R_1$ ,  $C_1$  and Oscillation Frequency

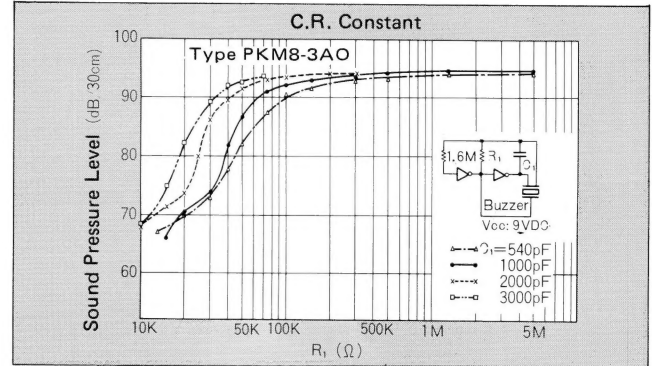


Fig. 11 Relations of  $R_1$ ,  $C_1$  and Sound Pressure Level

## 4. External-Drive Oscillation

### 4-1 Product list: Piezo-electric buzzers of external-drive oscillation type

Murata's standard items specially selected out of the sound

elements and sound elements with cases of external-drive oscillation type are listed in Table 6 and 7. Order manufacturing is possible when special specifications are required for the size of piezo-electric elements, materials, shape and size of metal plates, lead wires and case shapes and so forth.

Table 6. Product List of Sound Elements of External-Drive Type

Type	Part Number	Characteristics (※1, ※2)			Dimensions (mm)					N, B
		Resonant frequency (KHz)	Resonant resistance ( $\Omega$ )	Capacitance (pF)	$\phi$ D	a or c	b or d	T	t	
Flat plate type.	7BB-20-6	6.3 $\pm$ 0.6	$\leq$ 350	10000 $\pm$ 30%	20.0 $\pm$ 0.2	14.0 $\pm$ 0.6	12.8 $\pm$ 0.2	0.42 $\pm$ 0.1	0.20 $\pm$ 0.05	—
	7BB-27-4	4.6 $\pm$ 0.5	$\leq$ 200	20000 $\pm$ 30%	27.0 $\pm$ 0.2	19.7 $\pm$ 0.6	18.2 $\pm$ 0.2	0.54 $\pm$ 0.1	0.30 $\pm$ 0.05	—
	7BB-35-3	2.8 $\pm$ 0.5	$\leq$ 200	30000 $\pm$ 30%	35.0 $\pm$ 0.2	25.0 $\pm$ 0.6	23.0 $\pm$ 0.2	0.53 $\pm$ 0.1	0.30 $\pm$ 0.05	—
	7BB-41-2	2.2 $\pm$ 0.3	$\leq$ 250	30000 $\pm$ 30%	41.0 $\pm$ 0.2	25.0 $\pm$ 0.6	23.0 $\pm$ 0.2	0.63 $\pm$ 0.1	0.40 $\pm$ 0.05	—
	7SB-20-7	7.2 $\pm$ 0.8	$\leq$ 350	10000 $\pm$ 30%	20.0 $\pm$ 0.2	14.0 $\pm$ 0.6	12.8 $\pm$ 0.2	0.42 $\pm$ 0.1	0.20 $\pm$ 0.05	SUS plate
	7SB-21-7	6.6 $\pm$ 0.8	$\leq$ 250	11000 $\pm$ 30%	21.0 $\pm$ 0.2	16.0 $\pm$ 0.6	14.0 $\pm$ 0.2	0.36 $\pm$ 0.1	0.15 $\pm$ 0.05	SUS plate
	7SB-27-5	4.8 $\pm$ 0.5	$\leq$ 200	18000 $\pm$ 30%	27.0 $\pm$ 0.2	10.7 $\pm$ 0.6	18.2 $\pm$ 0.2	0.54 $\pm$ 0.1	0.30 $\pm$ 0.05	SUS plate
	7BB-20-6A0	6.3 $\pm$ 0.6	$\leq$ 550	10000 $\pm$ 30%	20.0 $\pm$ 0.2	14.0 $\pm$ 0.6	12.8 $\pm$ 0.2	0.42 $\pm$ 0.1	0.20 $\pm$ 0.05	With lead wire AWG32 f : 50 $\pm$ 5 g : 5 $\pm$ 2 (unit: mm)
	7BB-27-4A0	4.6 $\pm$ 0.5	$\leq$ 200	20000 $\pm$ 30%	27.0 $\pm$ 0.2	19.7 $\pm$ 0.6	18.2 $\pm$ 0.2	0.54 $\pm$ 0.1	0.30 $\pm$ 0.05	
	7BB-35-3A0	2.8 $\pm$ 0.5	$\leq$ 200	30000 $\pm$ 30%	35.0 $\pm$ 0.2	25.0 $\pm$ 0.6	23.0 $\pm$ 0.2	0.53 $\pm$ 0.1	0.30 $\pm$ 0.05	
	7BB-41-2A0	2.2 $\pm$ 0.3	$\leq$ 300	30000 $\pm$ 30%	41.0 $\pm$ 0.2	25.0 $\pm$ 0.6	23.0 $\pm$ 0.2	0.53 $\pm$ 0.1	0.40 $\pm$ 0.05	
	7BB-20-12R5RM-7	7.4 $\pm$ 0.7	$\leq$ 1000	10000 $\pm$ 30%	20.0 $\pm$ 0.2	12.5 $\pm$ 0.5	—	0.45 $\pm$ 0.1	0.20 $\pm$ 0.05	Ni-electrode
	7BB-27-12R5RM-4	3.8 $\pm$ 0.5	$\leq$ 800	10000 $\pm$ 30%	27.0 $\pm$ 0.2	12.5 $\pm$ 0.5	—	0.55 $\pm$ 0.1	0.30 $\pm$ 0.05	
	7BB-20-12R5RM-7A0	7.4 $\pm$ 0.7	$\leq$ 3000	10000 $\pm$ 30%	20.0 $\pm$ 0.2	12.5 $\pm$ 0.5	—	0.45 $\pm$ 0.1	0.20 $\pm$ 0.05	Ni-electrode With lead wire AWG28
	7BB-27-12R5RM-4A0	3.8 $\pm$ 0.5	$\leq$ 2500	10000 $\pm$ 30%	27.0 $\pm$ 0.2	12.5 $\pm$ 0.5	—	0.55 $\pm$ 0.1	0.30 $\pm$ 0.05	
	8SB-27-19R7DM-3	3.0 $\pm$ 0.5	$\leq$ 200	90000 $\pm$ 30%	—	19.7	27.0	0.21	0.10	※3
	8BB-35-25DM-2	1.9 $\pm$ 0.5	$\leq$ 200	140000 $\pm$ 30%	—	25.0	35.0	0.21	0.10	
Saucer type.	7SB-21R5-6-1	6.5 $\pm$ 0.6	$\leq$ 250	11000 $\pm$ 30%	21.5 $\pm$ 0.05	16.0 $\pm$ 0.5	19.0 $\pm$ 0.1	0.90 $\pm$ 0.05	0.10 $\pm$ 0.03	—
	7SB-31R8-2	3.8 $\pm$ 0.5	$\leq$ 300	18000 $\pm$ 30%	31.8 $\pm$ 0.1	19.7 $\pm$ 0.6	27.7 $\pm$ 0.2	0.90 $\pm$ 0.1	0.15 $\pm$ 0.03	—
	8SB-31R8-19R7DM-2-1	2.2 $\pm$ 0.3	$\leq$ 200	90000 $\pm$ 30%	—	19.7	31.8	0.90	0.10	※3
★	7BB-19-8-1	7.2 $\pm$ 0.8	$\leq$ 200	11000 $\pm$ 30%	18.8 $\pm$ 0.1	16.0 $\pm$ 0.5	—	0.45 $\pm$ 0.1	0.25 $\pm$ 0.03	—
	7BB-41-2A1	1.7 $\pm$ 0.3	$\leq$ 1000	30000 $\pm$ 30%	41.3 $\pm$ 0.48	24.9 $\pm$ 0.5	—	0.63 $\pm$ 0.1	—	—

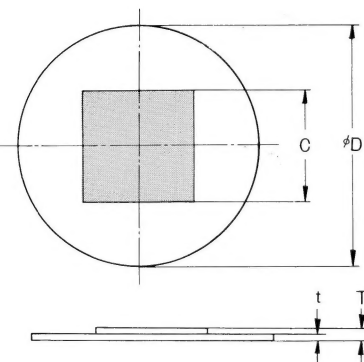
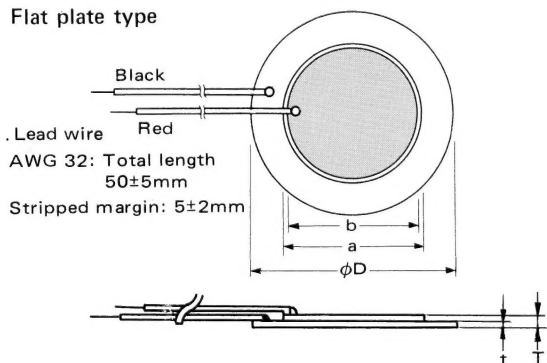
★ Printed board plug-in type

※1 Insulation resistance 100M $\Omega$  min. (at 100VDC)

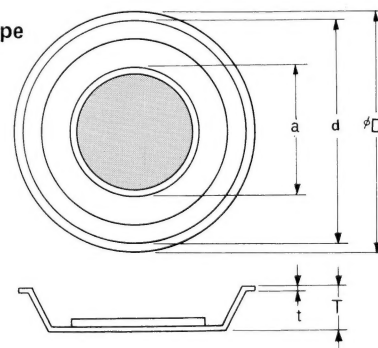
※2 Maximum applied voltage 30Vp-p

※3 for Melody Alarm

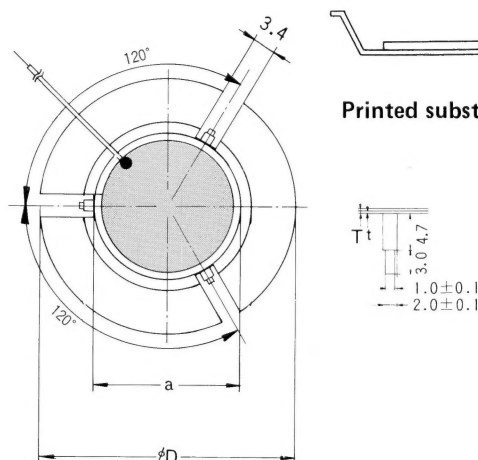
#### Flat plate type



#### Saucer type



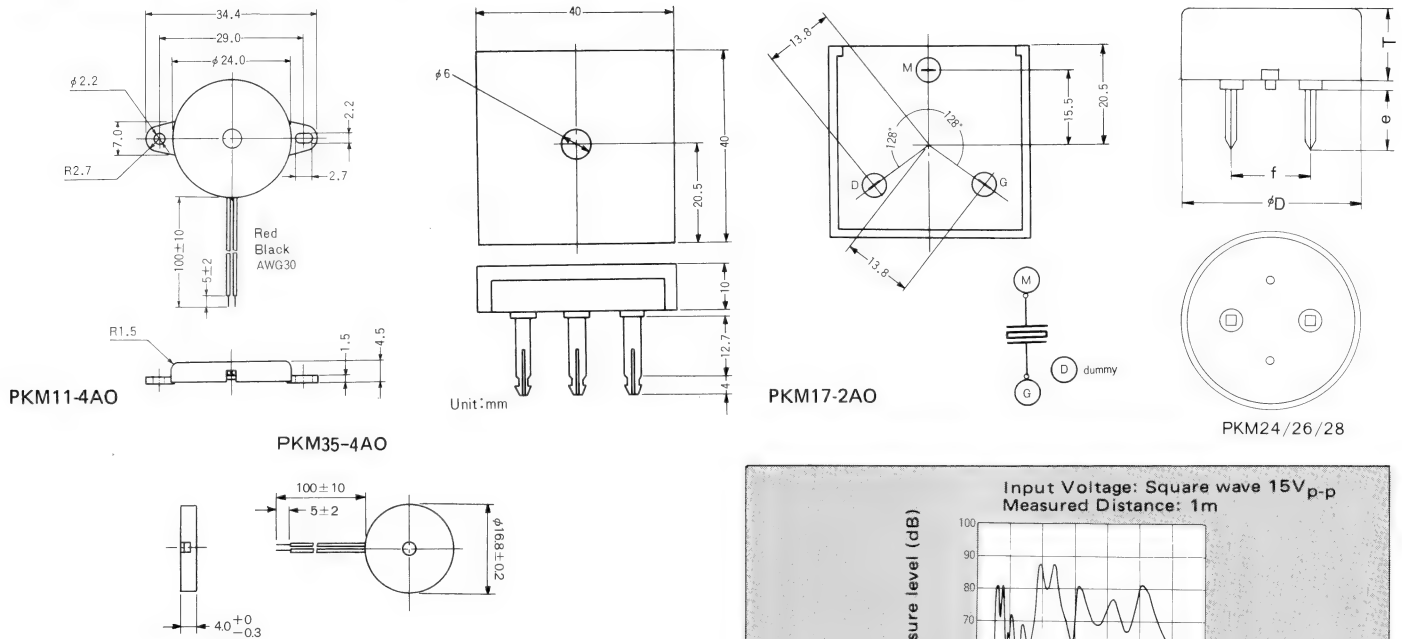
#### Printed substrate plug-in type



Unit: mm

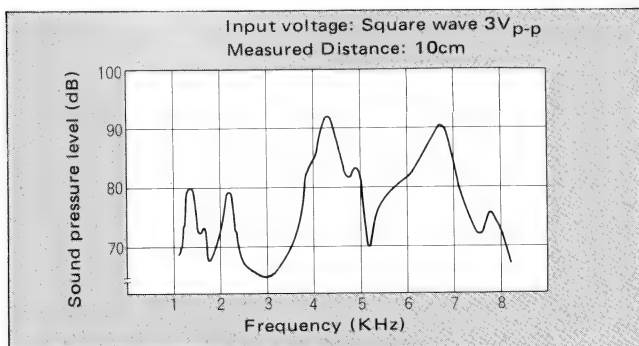
**Table 7. Product List of Sound Elements with Case of External-Drive Type**

Part No.	Characteristics					Operation range		Dimensions (mm)			
	f (KHz)	SPL (dB)	I (mA)	C (pF) $\pm 30\%$	Conditions	(Vp-p) Voltage	(°C) Temp.	$\phi$ D	T	e	f
PKM11-4AO	4.096	$\geq 75$	$\leq 1$	10000	3Vp-p Square Wave 10cm	< 25	-30~+70	—	—	—	—
PKM17-2AO	1.80 & 2.25	$\geq 70$	$\leq 1$	24000	15Vp-p 1m	< 25	-30~+70	—	—	—	—
PKM24-4AO	4.096	$\geq 75$	$\leq 1$	12000	3Vp-p Square Wave 10cm	< 25	-30~+70	22.0	7.0	6.5	10.0
PKM26-3AO	2.5	$\geq 75$	$\leq 2$	18000	9Vp-p Square Wave 30cm	< 25	-30~+70	30.0	10.0	4.8	13.0
PKM28-2AO	2	$\geq 75$	$\leq 2.5$	26000	9Vp-p Square Wave 30cm	< 30	-30~+70	38.0	9.0	4.0	20.0
PKM35-4AO	4.096	$\geq 75$	$\leq 1$	9500	3Vp-p Square Wave 10cm	< 25	-20~+70	—	—	—	—

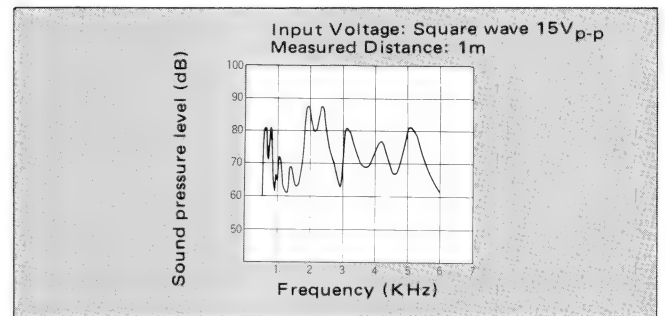


#### 4-2 Frequency characteristics of PKM11-4AO and PKM17-2AO (PKM28-2AO)

Fig. 12 and 13 indicate the frequency characteristics of respective sound pressures. PKM11-4AO is designed to have large sound pressure levels at 2048Hz and 4096Hz. Both levels are impressed with square waves of 3V<sub>p-p</sub>, measured at the interval of 10cm. More than 70dB and 75dB are guaranteed respectively. PKM17-2AO (PKM28-2AO) is developed for ringing circuit by us in Fig. 15 (c) having twin peaks near 1.8kHz and 2.25kHz. The above frequency characteristics are measured by square waves however cares must be taken when sine waves are applied since sound pressure peaks below 3kHz for PKM11-4AO or below 1.5kHz for PKM17-2AO become substantially small.



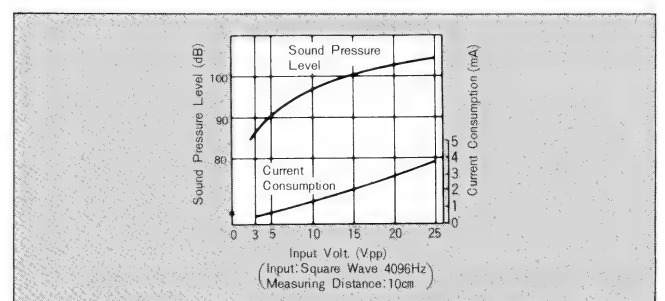
**Fig.12. PKM11-4AO: Characteristics of Sound Pressure Level vs Frequency**



**Fig.13. PKM17-2AO (PKM28-2AO): Characteristics of Sound Pressure Level vs Frequency**

#### 4-3 Sound pressure and consumption current characteristics vs input voltage of PKM11-4AO

As Fig. 14 indicates, both sound pressure and consumption current show linear relations to the change in input voltage. This linear trend can be observed in all other sound elements regardless of types. The figure sets forth the perceptible improvement of piezo-electric buzzers in energy-saving, e.g. less than 1mA for 3V<sub>pp</sub>, in comparison with other buzzers.

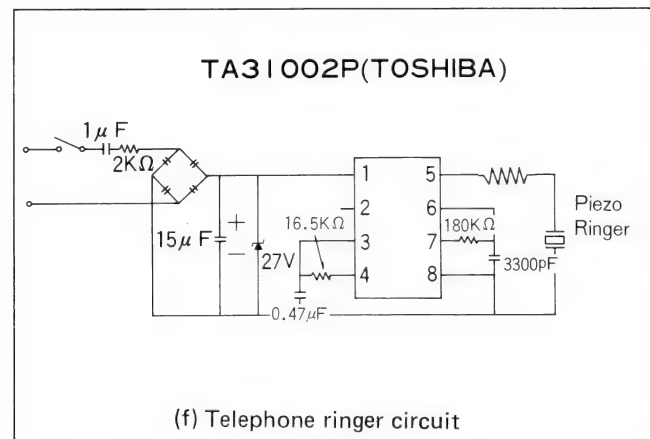
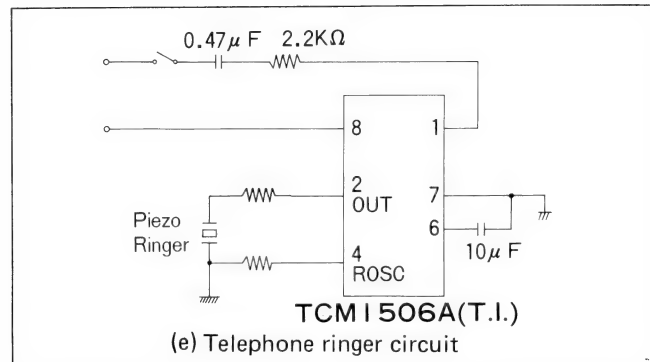
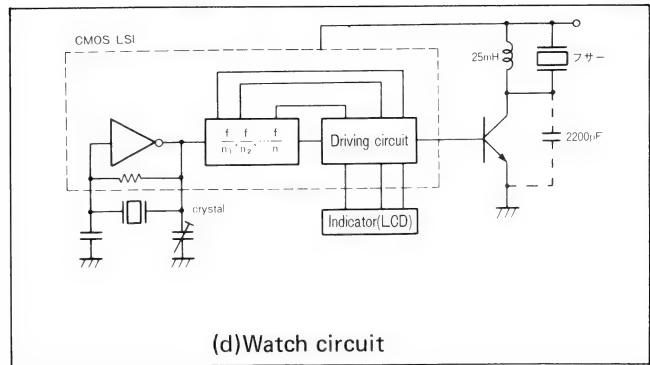
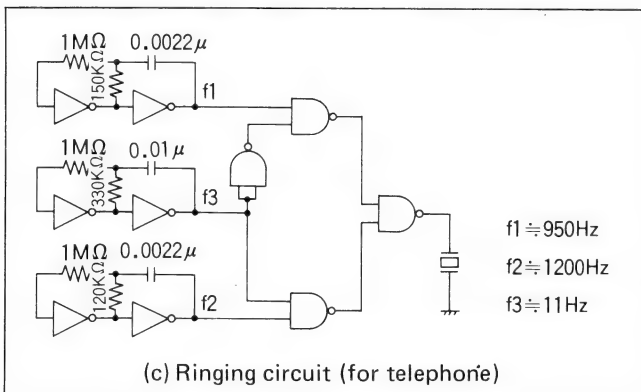
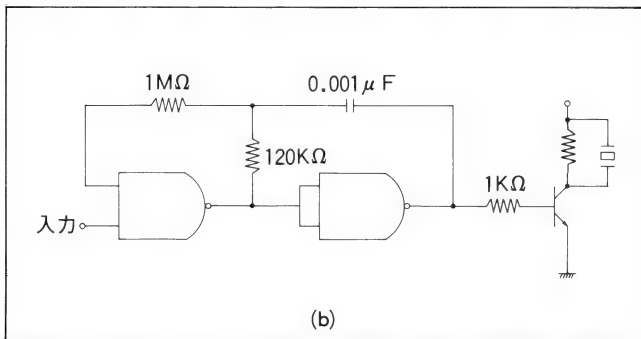
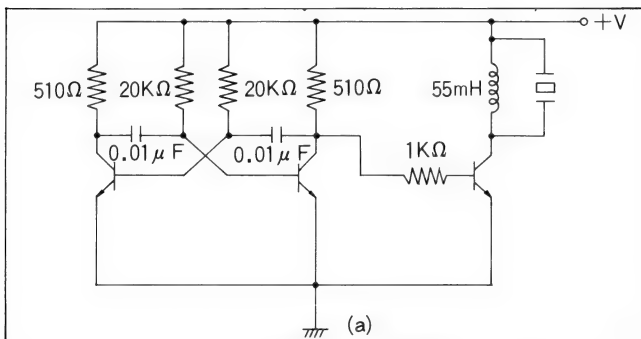


**Fig.14. PKM11-4AO: Characteristics of Sound Pressure Level vs Input Voltage**

#### 4-4 External-drive circuit

The piezo-electric buzzers are employed for use in watches, calculators, game machines and others because of its small electric consumption and ultra-thin size. Currently they are rapidly penetrating into the micro-computer related products (micro-wave ovens, stereos, TV sets, washing machines and cars). The development of LSI for communication has opened up the new field of application, telephone facsimile.

**Fig. 15** portrays an example of the circuit for external-drive oscillation. (a) is the circuit in which the free running multi-vibrator with Tr is boosted by the coil and others, whereas (b) indicates the oscillating circuit with two units of NAND gate ICs which oscillates or stops by ON and OFF change-over of input signals, (c) describes the ringing tone circuit (telephone sound) which produces ringing with  $f_3$  cycles between  $f_1$  and  $f_2$ , (d) is the watch circuit with LSI, and (e) and (f) show the circuit examples of piezo ringer connected to the ICs for telephone ringer. Please take care in circuit design so that the DC voltage is not applied to the piezo-electric buzzers for a long time.

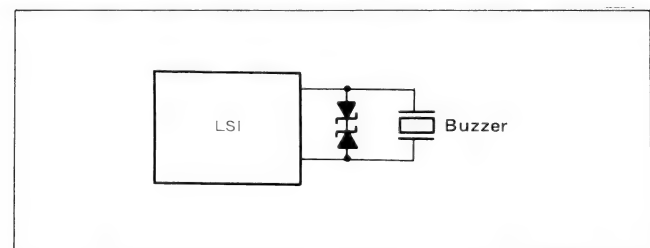


**Fig. 15 Example of External-drive Circuit**

#### 4-5 Installation

1) LSI might be destroyed by the high voltage due to the heavy electric load in the sound element after certain thermal or mechanical shocks.

The zener diode is sometimes employed as one of the protections for LSI as shown in Fig. 16.

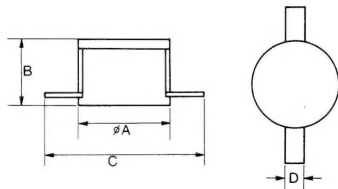


**Fig. 16 External Protection Circuit for LSI**

## 5 Employment of boosting coil

The boosting coil is employed to compensate the sound pressure for attenuation caused by the external case such as watches. When Tr is switched on and off by the output voltage of LSI with  $t$  sec. of rise or fall time, the back voltage proportional to  $\frac{L}{t}$  is also generated in the coil of inductance L. The sound pressure can be gained in proportion to the back voltage having  $V_{p-p}$  more than several times bigger than the line voltage. Some examples of small-size boosting coils we produced are shown in Fig. 17 and Table 8.

**Fig. 17 Examples of Boosting Circuit for Piezo-Electric**



※ Terminal is metallic.

**Table 8.**

Part No.	Electric Characteristics		Dimensions (mm)			
	L (mH)	R <sub>DC</sub> (Ω)	A	B	C	D
FKPC032MH	10 Min.	175±15%	3.0 Max.	2.0 Max.	5.2±0.2	0.8±0.2
FKPC031MH18	14 <sup>+40%</sup> <sub>-45%</sub>	135±10%	3.45 Max.	1.6 Max.	5.4±0.2	0.8±0.2
FKPC031MH04	8 Min.	120±10%	3.45 Max.	2.0 Max.	5.4±0.2	0.8±0.2
FKPC031MH03	11 Min.	136±15%	3.45 Max.	2.4 Max.	5.4±0.2	0.8±0.2
PKPC041MH02	25Min.	60±10%	9.0 <sup>+0</sup> <sub>-0.3</sub>	2.0 <sup>+0</sup> <sub>-0.3</sub>	6.4±0.2	0.9Max.

## 6. Environmental Test Data / Other Data

Data on various environmental tests for PKB5-3AO (7BB-35-3C + Case + Circuit) are shown in Fig. 18~29. The variations of characteristics in the figures can be regarded as negligible for actual applications.

The relations between distance and sound pressure (Fig. 30), and the frequency characteristic of human auditory sense are shown in Fig. 31 for reference as additional data.

Test Name	Condition	Figure
Damp heat test (steady state)	+60°C RH90~95% 1000 hrs	Fig. 18
Cold test	-20°C 1000 hrs	Fig. 19
Dry heat test	+70°C 1000 hrs	Fig. 20
Vibration test	10~500~10Hz 15 minutes sweep 3 directions for 2 hours each	Fig. 21
Mechanical shock test	100G half sin. 3 directions for 3 times each	Fig. 22
Salt mist test	+35°C 5% 96 hrs	Fig. 23
Temperature change test	-20°C 30 minutes~+25°C 15 minutes~+70°C 30 minutes, 5 cycles	Fig. 24
Damp heat (cyclic) test	+25°C RH 60%~+65°C. RH 90%, 10 cycles	Fig. 25
Damp heat (steady state) test	+40°C RH 90~95% DC 9V	Fig. 26
Dry heat test	+70°C DC 9V Fig. 26	Fig. 27
Intermittent sound test	+25°C 1.5 sec. ON - 1.5 sec. OFF DC 9V, 30,000 times	Fig. 28
Ambient temperature	-20°C~+60°C	Fig. 29

Table 10. Environmental Test Conditions

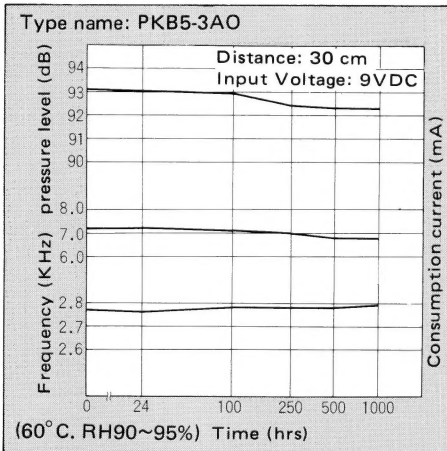


Fig. 18. Damp Heat (Steady State) Test

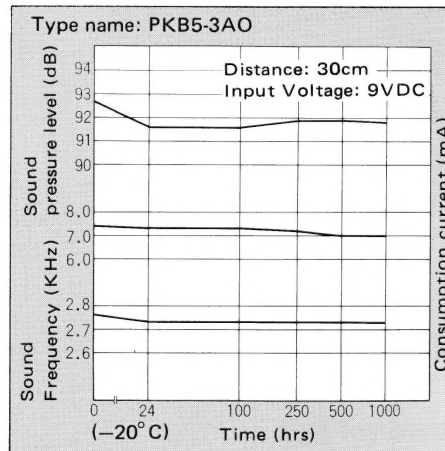


Fig. 19. Cold Test

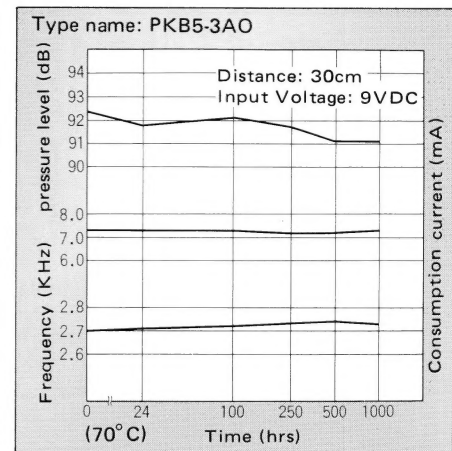


Fig. 20. Dry Heat Test

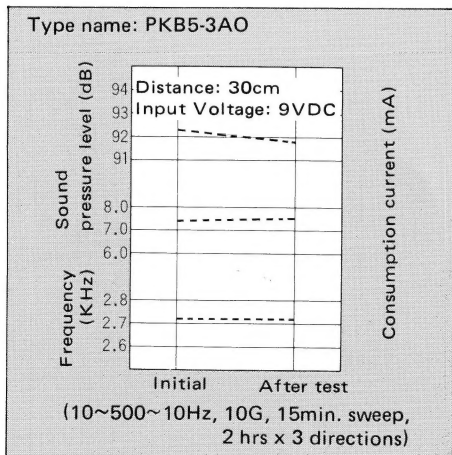


Fig. 21. Vibration Test

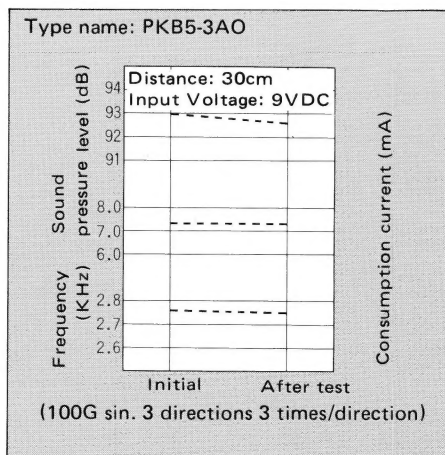


Fig. 22. Mechanical Shock Test

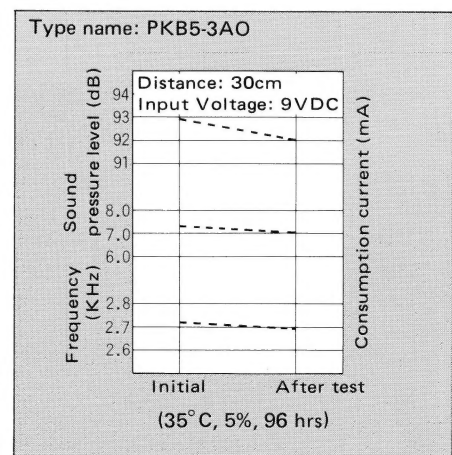


Fig. 23. Salt Mist Test

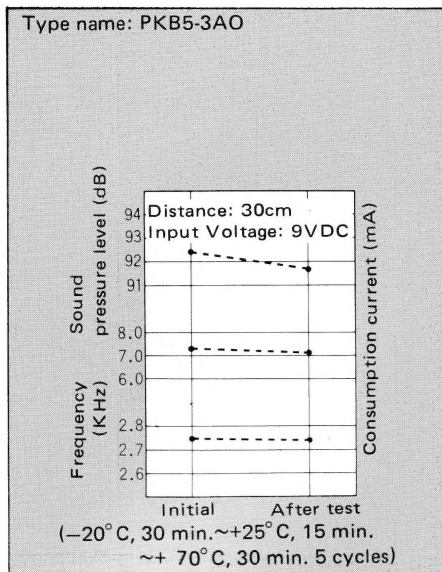


Fig. 24. Temperature Change Test

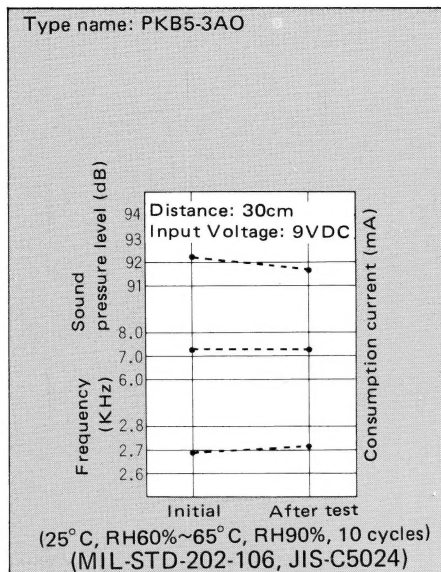


Fig. 25. Damp Heat (Cyclic) Test

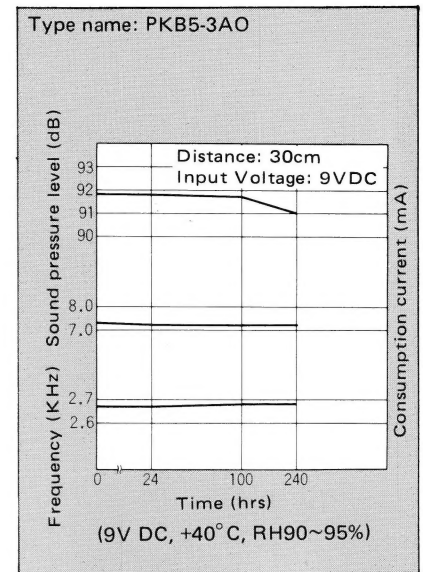


Fig. 26. Damp Heat (Steady State) Test

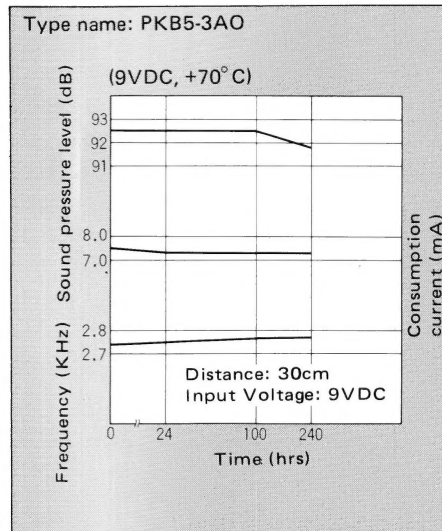


Fig. 27. Dry Heat Test

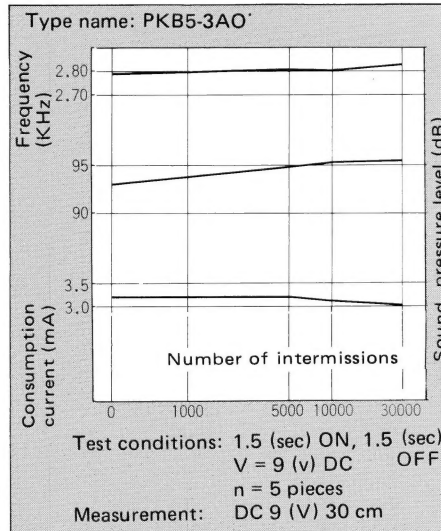


Fig. 28. Intermittent Sound Test

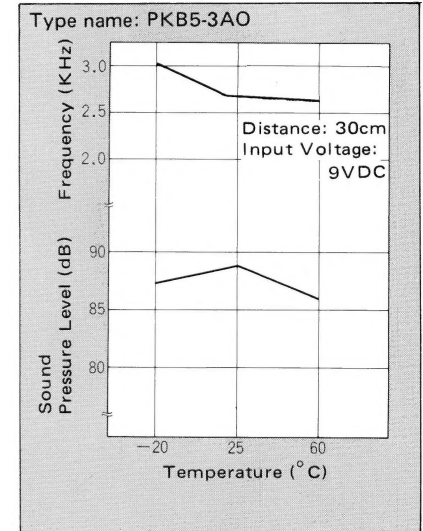


Fig. 29. Ambient Temperature

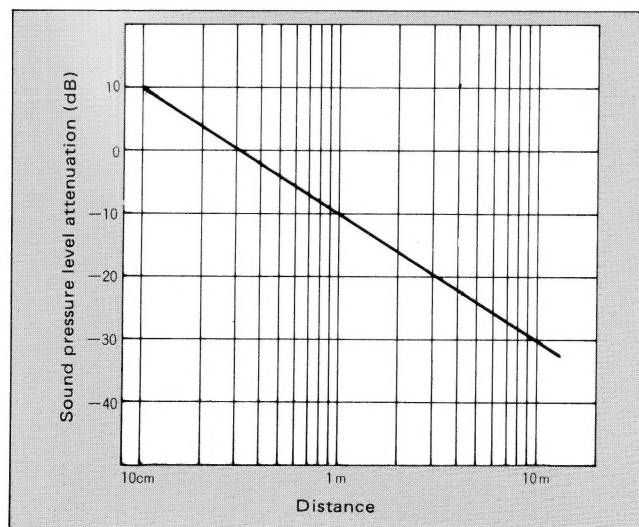


Fig. 30. Relations between Distance and Sound Pressures

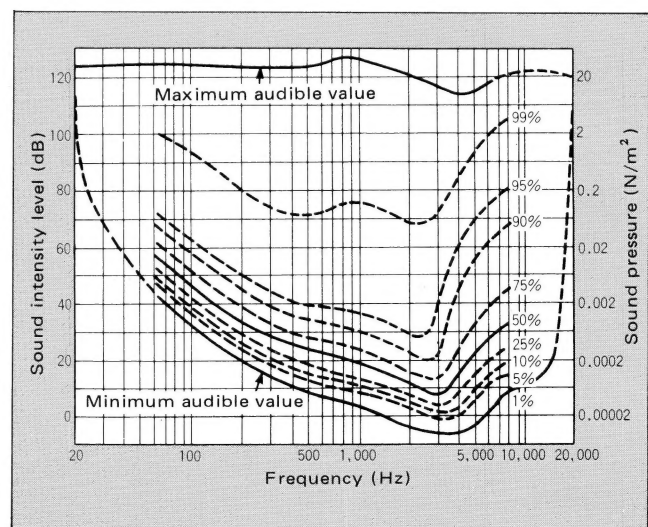


Fig. 31. Range of Audible Value

※Please, confirm the type and rated value upon ordering as they are subject to change for improvement without notice. Please contact us for further information.

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